Space Weather Technical Forecast

Issued on Friday, 14 June 2024 at 12:24 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1/Minor Geomagnetic Storm Day 2 (15 Jun). Isolated M-flares (R1-R2 radio blackouts) likely throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Moderate, with two isolated M-flares: an M3.2 at 13/1645 UTC attributed to AR3713 in the southeast and an M2.4 at 14/0432 UTC attributed to AR3712, also in the southeast. There are currently 8 sunspot regions on the visible disc, the largest and most significant being AR3712 in the southeast. This region continues to develop in size and complexity and is now classified as an Eki/Beta-Gamma-Delta with at least one delta spot visible. AR3713 and AR3716, both in the eastern hemisphere, have also developed slightly gaining a number of intermediate spots strengthening lead and/or trail portions. AR3709, close to centre disc, is a slightly smaller mature region, consisting of a single leader followed by smaller trailing spots and has shown slight decline in recent hours. The other regions are relatively small and simple.

No Earth directed CME's were observed during the period, with a prominence eruption from the northeast limb around 13/1700UTC not considered to have an Earth directed component.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by ACE at L1, were indicative of a slow regime. The speed was slow-ambient and generally stable, varying between 300-360 km/s, with below average density. The IMF (Interplanetary Magnetic Field), Bt, was weak throughout. Until 14/0240 UTC it was relatively stable before increasing slightly to a peak of 6 nT. The north-south component, Bz, fluctuated weakly initially, but since 14/0240 UTC has remained predominantly southward with a range of -5/+3nT during the period. The phi angle was predominantly positive (away from the Sun), until 13/1707 UTC and again from 14/0700 UTC with a prolonged negative (towards the Sun) period in between. Since 14/0800 UTC the phi angle has fluctuated between positive and negative. Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: The high-energy (greater than 10 MeV) proton flux observed by GOES18 remained below the S1 threshold and has been declining through the period, returning to background levels around 12/1120 UTC.

High energy electron flux (greater than 2MeV) observed by GOES16 was at background to moderate, with the associated 24-hour fluence well below Active. Observed fluence at 14/0000 UTC was 1.2e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Further isolated M-class flares are likely, with just a slight chance of X-flares. Any significant flares most likely from AR3712 and AR3713. No new regions are expected to rotate onto the visible disc during the period.

Solar Wind / Geomagnetic Activity: A faint CME associated with a M1 flare at 12/2246 UTC is now considered to have an Earth directed component, reaching Earth later on Day 2 (15 Jun). Confidence is low regarding the arrival time and impact. Currently only G1/Minor Geomagnetic

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storm intervals (Kp 5) are anticipated. A high speed stream from CH45/+ may connect to Earth during Day 3 (16 Jun) with uncertain enhancement, perhaps seeing winds increase to 450-500km/s with the possibility of a few Unsettled or possibly Active (Kp 3-4) intervals.

Geomagnetic activity is expected to remain Quiet (Kp 0-2) through Day 1 (14 Jun) and the start of Day 2 (15 Jun) before increasing upon arrival of the forecast CME to Active or G1 (Kp 4-5), with a slight chance of reaching Moderate/G2 (Kp 6). Geomagnetic levels then decline to Quiet to Unsettled (Kp 2-3) for the remainder of the period with a chance of isolated Active (Kp 4) intervals associated with HSS enhancement.

Energetic Particles / Solar Radiation: High energy proton flux is expected to continue to decline over the coming days, remaining below the S1/Minor storm levels. The chance of enhancement continues to decline.
High energy electron flux is forecast to persist at predominantly background levels, and the associated 24-hour fluence is expected to remain below the Active threshold.

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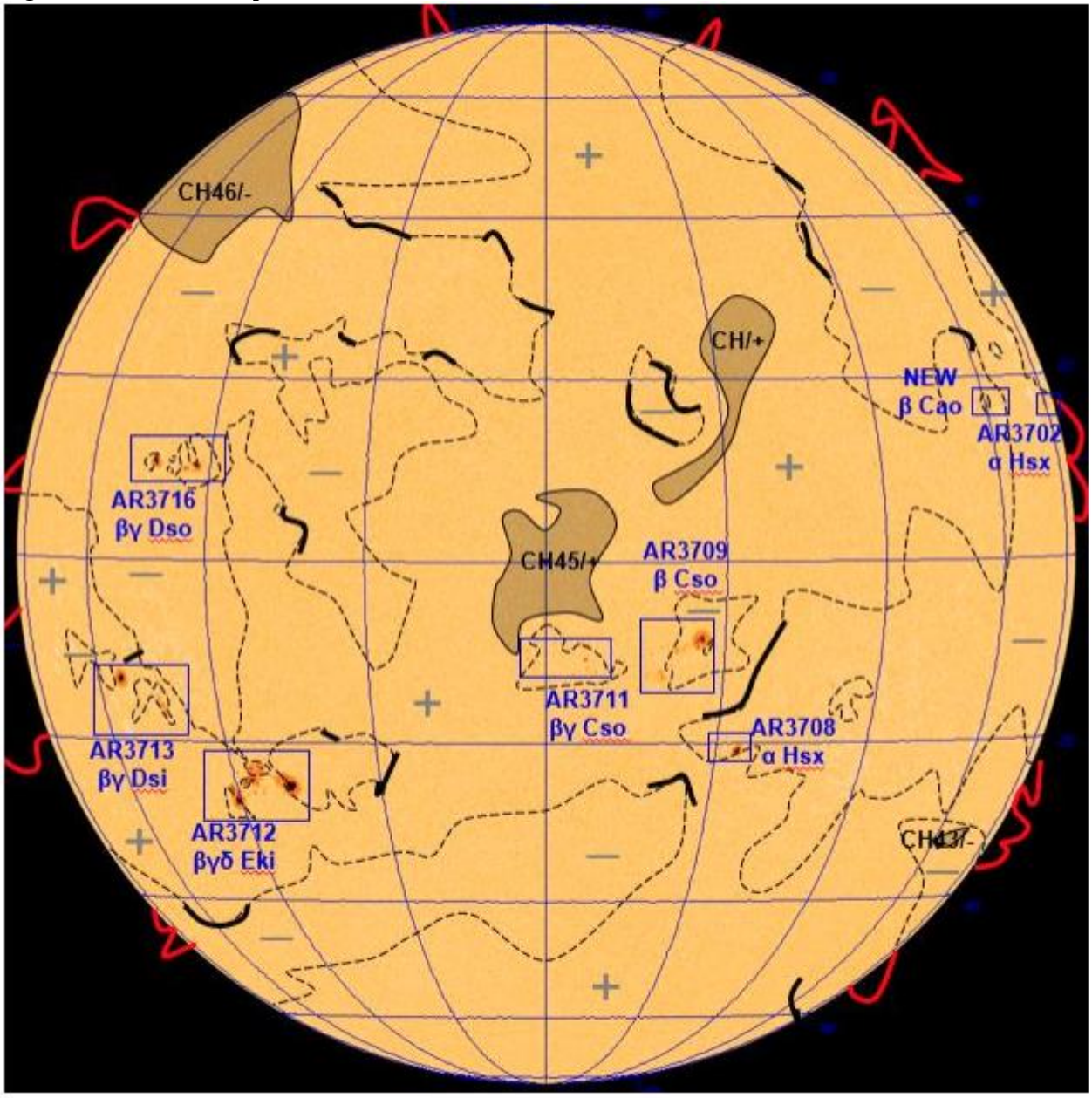
Figure 1. Solar Analysis Valid 14/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A faint CME associated with a M1 flare at 12/2246 UTC from AR3711 has been reanalysed and is considered to have an Earth directed component, reaching Earth later on Day 2 (15 Jun). Confidence is low regarding the arrival time and impact, due to the weak nature of the CME and gaps in the imagery for analysis. Currently only G1/Minor Geomagnetic storm intervals (Kp 5) are anticipated.

A high speed stream associated with coronal hole feature CH45/+ near centre disc may connect with Earth on Day 3 (16 June). This feature is not recurrent, as such, it is difficult to confidently forecast the level of geomagnetic response upon connection. However, due to the proximity to the solstice and the size and the strength of the coronal hole solar wind speeds of 450-500 km/s are anticipated with the possibility of a few Unsettled or possibly Active (Kp 3-4) geomagnetic intervals. Enlil models the HSS to arrive on the 17 Jun (Day 4) which is considered too late.
Overall geomagnetic activity is expected to remain Quiet (Kp 0-2) through Day 1 (14 Jun) and the start of Day 2 (15 Jun) before increasing upon arrival of the forecast CME to Active or G1 (Kp 4-5), with a slight chance of reaching Moderate/G2 (Kp 6). Geomagnetic levels then Quiet to Unsettled (Kp 2-3) for the remainder of the period with a chance of isolated Active (Kp 4) intervals associated with the arrival of any coronal hole enhancement.

Geo-Magnetic Storm / Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	50	10	10
Strong	G3	No	1	1	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
13/013	Full	AR3711	SE	850	14/1200	Low confidence in arrival time. Unlikely to have significant impact.

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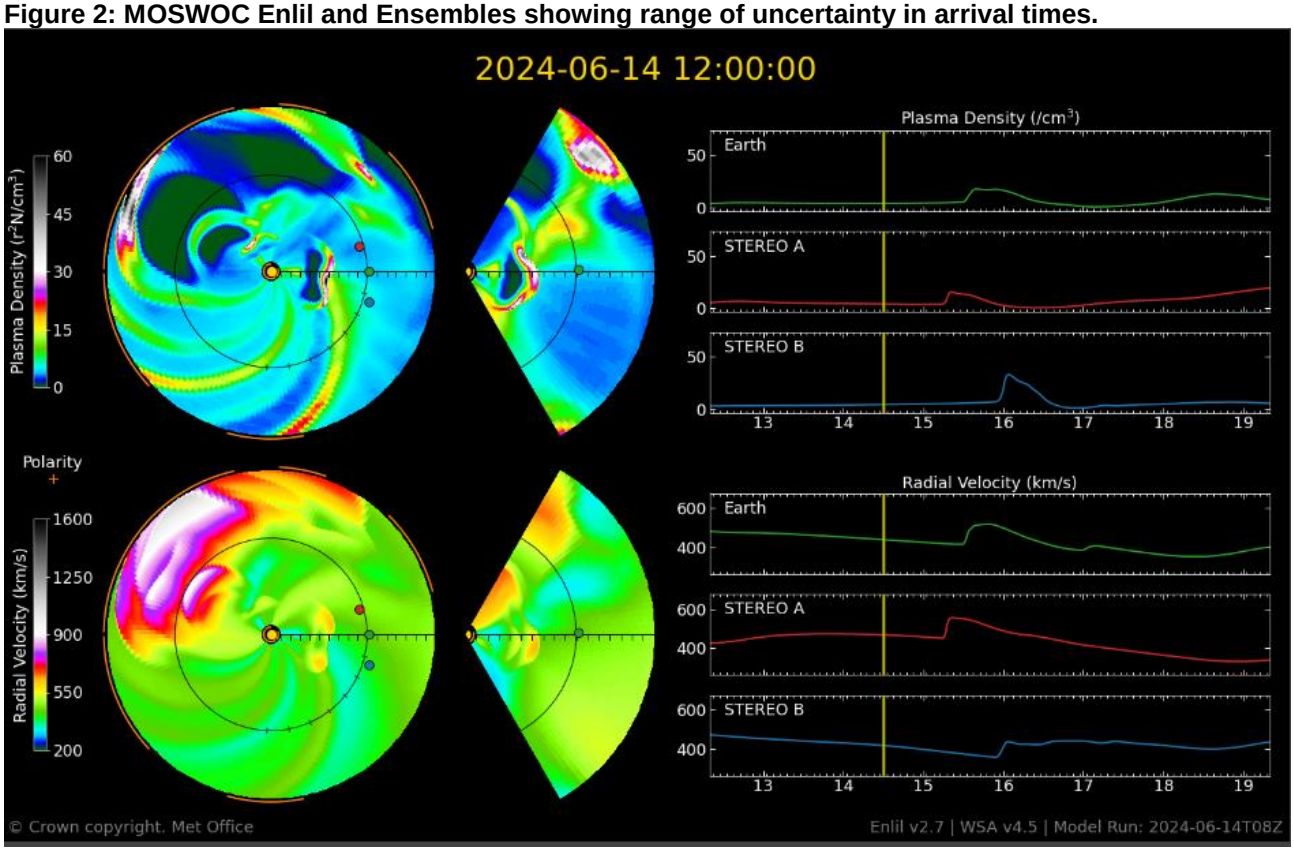
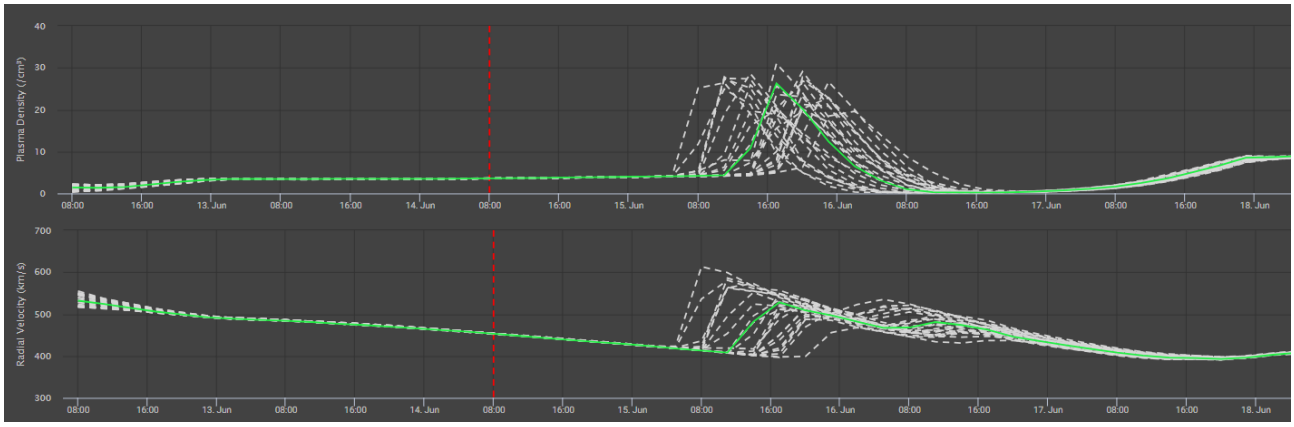
Figure 2: MOSWOC Enlil and Ensembles showing range of uncertainty in arrival times.





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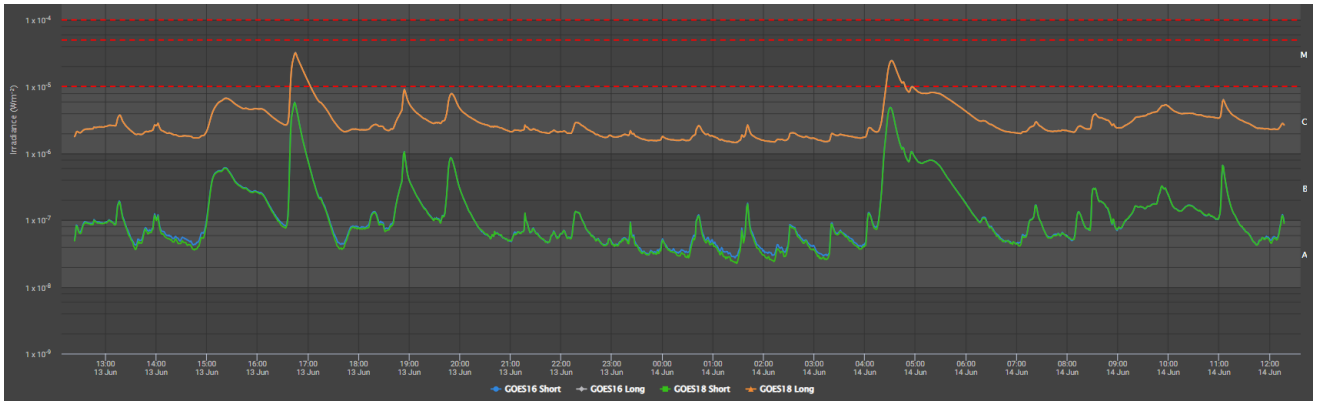
Radio Blackouts - X-Ray Flares:

There are currently 8 sunspot regions on the visible disc, although one is not numbered. AR3707 has faded to a pore and removed from analysis. The largest and most significant region remains AR3712 in the southeast. AR3712 consists of a number of large and strong spots in close proximity and a number of smaller intermediate spots that have emerged in recent hours. An increase in penumbra and the slight shearing of a leading spot has been observed as well as the presence of at least one delta spot. AR3713, also in the southeast hemisphere, has seen the proliferation of a number of small spots in its lead portion although remains unchanged in its classification. AR3716 in the north east has seen consolidation of a number of spots in the lead portion and an increase in complexity in its magnetic structure. The other regions are comparatively small and simple.

Further M-class flares are likely through the period, with only a slight chance of X-flares, most likely from AR3712 or AR3713. No new regions are expected to rotate onto the disc during the period.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	50	50	60	60
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES16 & GOES18 X-ray trace for past 24 hours



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Solar Radiation Storms - (High Energy Protons):
High energy proton flux is expected to continue to decline over the coming days, remaining below the S1/Minor storm levels as previous region AR3697 continues to rotate further across the far side and the most significant regions on the visible disc are currently in the eastern hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):
The high energy electron flux is expected to persist at generally background levels for much of this period with no or limited significant sources of enhancement expected. Some diurnal Moderate flux values are likely.

The associated 24 hour fluence is expected to remain well below the Active threshold (1e8 integrated pfu) and the MOSWOC REFM output is considered to provide reasonably good guidance, even if it seems to be slightly underestimating current levels. Any influence from the CME arrival on Day 2 (15 Jun) may act to further suppress electron flux values with any recovery or response not anticipated during the forecast period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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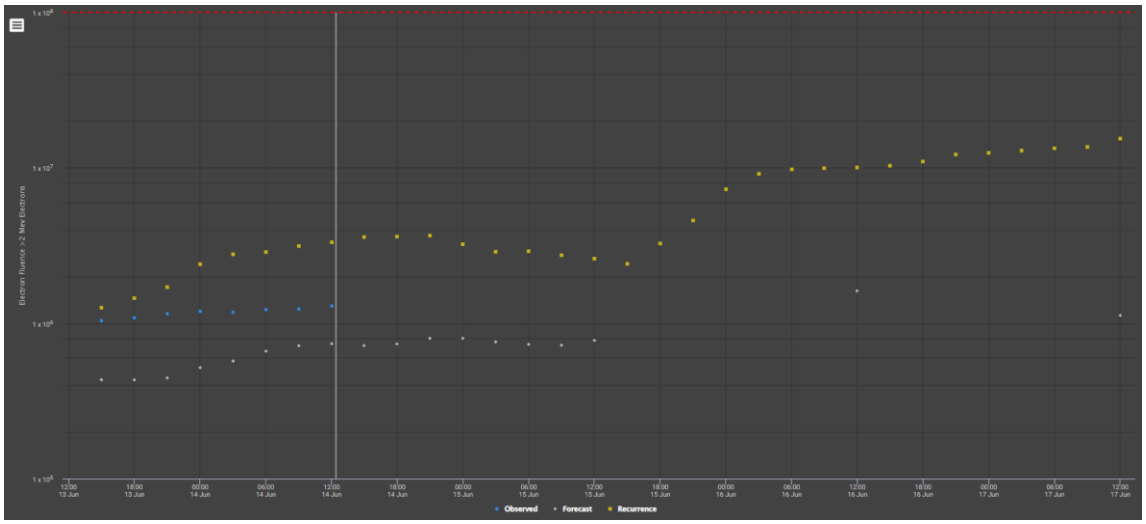
Figure 4: MOSWOC REFM Currently considered to be giving reasonable guidance on trend.



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